REVIEWS.

ART. X. *Grundriss der Physiologie.* Von Dr. KARL ASMUND RUDOLPHI, Prof. d. Med. und Mitgl. d. Königliche. Akad. d. Wissenschaften. Erster Band, Berlin, 1821. Zweiter Band, Berlin, 1823. Dritter Band, Berlin, 1828.

Elements of Physiology. By Dr. CHARLES ASMUND RUDOLPHI, Professor of Med. &c. Berlin, Vols. I., II., and III., 1821—1828.

EVERY one who feels the slightest zeal for the improvement of his profession, must experience the highest gratification when he looks around and perceives what it has already achieved—the rapid advancements which it is daily making—and reflects upon the high destinies which await it. Medicine has already been divested of the mysticism which for so many centuries served to obscure its principles; the domain of pathology no longer consists of an assemblage of vague hypotheses, but is based upon principles as immutable as truth; and physiology, which could scarcely be said to have had an existence before the time of the immortal HALLER, has, within the space of a few years, acquired a degree of improvement and elevation, which renders it a proud monument of human ingenuity and industry. In this important achievement the resources of different nations have been contributive, and if the exertions of one have availed more than those of another, all have just reason to be proud of the share they have individually performed, and the splendid consummation they have conjointly brought about. We propose, on the present occasion, to call the attention of our readers to the labours of Professor Rudolphi, of Berlin, in this important cause: a name already signalized in science, by his masterly researches upon the subject of intestinal worms, and other works of the highest merit.

Physiology is divided by Professor Rudolphi into general and special. General physiology he divides into the following heads:—"*a.* Anthropology.—*b.* Anthropotomy.—*c.* Anthropo-chemistry.—*d.* Zoonomia."

Under the head of special physiology are included—"*a.* Sensibility.—*b.* Motility.—*c.* Nutrition.—*d.* Generation."

The utility of such an arrangement is too manifest to require any particular exemplification. It is, indeed, only by pursuing such a

course that the science of physiology can be unfolded and displayed in all its natural richness. When examined in these extensive relations, it does not merely present an exposition of the uses of the organs, but displays itself under the more exalted aspect of the science of organized nature. The functions of the organs are so intimately dependant upon each other, that none of them can be properly performed except by the perfect co-operation of the whole, and we can only render the science of life contributive to valuable and important conclusions by considering it in these relations. The mere examination of the functions in an isolated manner, can only tend to bewilder us in vague and hypothetical conceptions. In this respect modern physiology has become particularly rich in important conclusions, since, by examining the properties of the organization in its general, as well as in its special relations, we are enabled to deduce from them valuable facts and important inferences, which, were we to confine our attention to the special consideration of the functions individually and separately, would ever remain concealed from our penetration. General physiology, as well as general anatomy, may be considered as one of the results of modern improvement, as it is only within the last half century that it has attracted much attention.

By anthropology is meant not only the consideration of those characters which are proper to man, and serve to distinguish him from all other beings, but also the similarities and dissimilitudes between him and the rest of creation. Our first object is, therefore, to determine his position in the scale of living beings, and to point out his relations with the other inhabitants of the earth.

1. *Difference between Man and Animals.*—Man is, from the physical characters of his organization, classed with the mammalia, at the head of which he is placed; but he approaches, in many of his characteristics, to the ape, hence the old observation—

"Simia quam similis turpissima bestia nobis."

This approximation of man to the monkey tribe has, however, been greatly exaggerated; for, although there are strong points of resemblance, those of contrast are equally well marked. One circumstance that has contributed to give currency to this belief, is the frequent stories of ourang-outangs, which have been said to approach the human subject in the characters of their organization, but which, the results of modern observations has rendered almost certain, are nothing more than young pongos. In determining, therefore, the difference between man and the monkey, we must examine both, after they have attained their full development, and not suffer

our opinions to be founded upon accidental, physical, or moral attributes.

One of the most constant and manifest differences between man and animals in general, as well as between him and the monkey, is his character of a rational being; the latter only possessing instioct, aod beiog altogether incapable of forming conceptions even of a general nature.

Man alone, amongst all the mammalia, walks in an upright positioo, for which the conformation of his pelvis, and other parts of his skeleton, are peculiarly adapted. Only a few animals resemble him io this particular, and they only present it as a temporary condition, for which the arrangement of their organs is not suited, whereas it is natural to man, and is presented by him in all ages and countries, even in the lowest state of barbarism.

The upright position, which is peculiar to man, only requires that he should have two feet articulated in such a manner as to admit of the free motion of the body upon them, by means of the action of strong muscles. The arm, moreover, presents a character peculiar to him: in consequence of the peculiar arrangement of the articulation of the shoulder, it admits of more rapid, and greater latitude of motion, than in any other animal. He has, in addition to this, a hand constructed with great wisdom, and fingers which are tactile in an exquisite degree.

In man, the occipital foramen corresponds to the centre of the base of the cranium, while in animals it is situated so far back as to throw the greater part, or the entire head, in front of the axis of the vertebra.

The brain in man, as the intellectual organ of a rational being, presents a preponderance of volume over the medulla spioalis; and the nerves, together with the organs of sense, possess a due proportion io their degree of development.

The large size of the brain makes the volume of the cranium preponderate over that of the face, and thus renders the facial angle more obtuse in man than in any other animal. His lower jaw is, on the other hand, shorter; the inter-maxillary bone does not exist, except as a mere rudiment in the fœtus only, and his chin projects forwards.

Man is not born with any natural weapons of defence, but forms to his wants, and by his own care and industry, such as may be necessary for his safety. He is almost daily making new discoveries; securing new acquisitions to the sense of human happiness, and is, in every sense of the word, king and lord of creation.

Of all animals, man alone is endowed with the faculty of speech, by which he is enabled to express his desires and aversions, and when, by any cause, he is deprived of the faculty of employing articulate sounds, he acquires a kind of language of gesticulation, or pantomime, which he makes supply most of the purposes of verbal language.

Man is capable of subsisting in every clime, and under every sky;—his race, therefore, extends with much greater facility than that of any other animal, and degenerates less under the influence of situation.

Animals rapidly attain the full development of their organs;—become early endowed with the venereal propensities, and acquire the full possession of all their peculiar attributes. Man, on the contrary, is charaeterized by a long childhood and youth, and is tardy in reachiog the state of manhood. He is brought into the world destitute of knowledge, but is throughout the entire period of his existence extending the bounds of human wisdom:—his mind is never satisfied with its acquisitions, and in the blessings of a future state, he hopes for a still further extension of his intelligence. He is, indeed, characterized by an unquenchable desire of a knowledge of all that is in heaven and earth: a disposition to pride himself on the high destiny which he alone, of all creation, is capable of attainiog; an impatience of contradiction that brooks no controul. Animals, on the other hand, can be influenced by the fear of punishment, to certain acts, but they possess no ideas of justice, nor are they sensible of the principles of either virtue or vice.

From all these considerations, it appears, that man is distinguished from the whole animal creation, by his being an intellectual and moral being—lord and king of creation in this life, and confident of a still higher destiny in the world to come.

2. *Varieties of the human race.*—"The entire human raee," says Professor Rudolphi, "distinguished from the rest of the animal creation, by the traits of charaeter just detailed, helongs to one genus, under which, however, are included a number of speeies and varieties, more or less different from each other, either as regards size, the arrangement of the body in general, or of some of its parts, especially the eranium and faee, in the strueture or colouration of the skin and hair, and above all, in their comparative capacities of perfeetibility, whieh are not possessed in an equal degree by all."

Many of these characters are more or less under the iofluence of climate, and the operation of other causes connected with the habits and modes of life which exist amongst differeot nations. Yet there seems to be a radical difference, which cannot be ascribed to the

agency of these causes. The height, especially, seems to be influenced by climate, inasmuch as we find a marked difference between those who inhabit warm, and those who dwell in the ice-bound regions of the arctic circle. The Patagonians attain the greatest height, their average stature being from six to seven feet, while the most diminutive are the Laplanders, Esquimaux, and the dwarfish inhabitants of the polar regions, who are scarcely five feet in height. Indeed, these realms of eternal snow seem to be alike inimical to animal and vegetable existence; for we not only find man under these inclement skies, stinted in the development of his organs, but the barren earth scarcely supports the dwarfish lichen, which affords but a miserable subsistence to the several creatures destined to endure the hardships of these unfriendly climes.

A much more important point of difference exists in the configuration of the body, which, when accurately considered in connexion with other traits, enables us to establish certain radical and well-founded divisions of the human race. The difference of configuration observed in the head and face is especially well-marked; as for example, in the comparative prominence of the forehead; its width and height, the degree of its inclination backwards; the projection of the chin forwards, and the perpendicular, or inclined direction of the alveolar processes. These varieties are not merely observed after the organs have reached their full growth, but are more or less manifest from the earliest months of the fœtal existence. To these must be added the comparative separation between the eyes, their prominence, the configuration of the nose and chin, the contracted eyelids, as in the Mongola, or the protuberant lip, as in the Æthiopian.

"The colour of the skin is, in some of the races white, in others brown, red, and black; even these present numerous shades or modifications. This difference of colour is not the result of accidental circumstances, as has been erroneously supposed, but is dependent upon a radical difference in the organization of the skin, which has existed from the earliest periods of the world. Corresponding varieties are observed in the hair. In the inhabitants of the north of Europe, it is of a light yellow colour, and of a fine texture—brown or black in the south, and much coarser. With the Hindoos, it is long and fine —with the American, long, thick, and glossy, and in the Æthiopian, black, coarse, and crisped."

Differences not less striking are observed in the comparative susceptibility of mental culture, possessed by the several races and varieties of man. Modifications, in this particular, are quite as numerous as those of colour, stature, configuration, and the other characters which have been enumerated;—and what is still more in-

teresting, is, that when we examine the several varieties of mankind, we find a constant and intimate correspondence between the development of the brain, and the activity of the intellectual powers. If, with Professor Rudolphi, we make four fundamental races or varieties of man, "the European, Mongolian, American, and Æthiopian," we shall find, that as regards intellectual capabilities, the European stands highest, from which there is a gradual diminution, until we arrive at the Æthiopian, who possesses the smallest capacity for mental culture, and who, in the meanness of his intellectual powers, is degraded almost below the level of human beings. It has been correctly conjectured by LAWRENCE, that—

"The retreating forehead, and the depressed vertex of the dark varieties of man, render it extremely doubtful whether they are susceptible of the higher destinies; whether they are capable of fathoming the depths of science;—of understanding and appreciating the doctrines and mysteries of religion."

It will be seen that Professor Rudolphi rejects the Malay race, which he does not think constitutes a proper variety, but supposes it to be made up of an admixture of others. We shall not follow the author through his description of the peculiarities which serve to distinguish the different races. They have been so often detailed in works on the subject, that they must be familiar to most of our readers. We shall therefore pass on to the examination of the second part of the first volume, which treats of

General Anthropotomy.—By this term Professor Rudolphi designates the consideration of the general characters of the organization, or the properties of the several tissues of which the entire organization is composed. It is therefore synonymous with general anatomy, employed by BICHAT, and in much more general use.

The proper element of all animal organization is, according to the author, a peculiar, delicate, homogeneous substance, susceptible of taking on different forms or modifications. In some animals, which are the most simple in their organization, it does not assume any other form, but in those whose organization is more perfect, it takes on several forms and modifications, constituting what are called tissues, and it is by the various combinations of these tissues, that the several systems or organs are formed. Our author, therefore, very correctly divides the tissues into simple and compound, or perhaps more correctly into simple tissues, properly so called, (*"partes simplices,"*) and into systems or organs, formed by the assemblage of two or more of these tissues, *(partes similares.)* The propriety of such an arrangement has been for a long time sensibly felt, and was acted upon by Haller, who considered the cellular, muscular, and nervous, as primitive or

simple tissues, and all the rest as compounds of these. Professor Rudolphi several years ago devoted considerable attention to the subject, which he elucidated with his accustomed ability in his work, "De Partibus Similaribus," Gryph, 1809, 4to. In the work before us, he makes the simple tissues, (partes simplices,) consist of the cellular, horney, cartilaginous, osseous, tendinous fibrous, vascular fibrous, muscular fibrous, and nervous fibrous. The compound tissues or systems, (partes similares,) are, 1st. The vascular, which is divided into general and special, the first including the arteries, veins and lymphatics, the latter, the excretory ducts of the glands, &c. 2d. The membranous is also divided into general and special, including under the first head, the serous, mucous, membranous fibrous, dermoid, and epidermoid. Under the special, the membranes of the ovum, the tunics of the eye, brain, &c. 3d. The viscera. And 4th. The glands.

It is not our intention to enter into any particular remarks upon this arrangement. Like all other attempts, having the same object in view, it has its advantages and defects, but may nevertheless be considered sufficiently accurate for all useful purposes. We cannot concur, however, in the propriety of separating the fibrous membranes from the other fibrous tissues possessing the same properties except in configuration. Nor do we think that the membranes of the brain, ovum, eye, &c. can be separated from the other tissues with which their properties are identical. Other objections to Professor Rudolphi's classification present themselves, but we do not think it a matter of sufficient importance to require further comment.

After having arranged the several tissues and organs in this manner, he goes on to consider their individual properties, which he does in a somewhat brief but satisfactory manner, his descriptions being in general accurate, embracing most that is requisite to the student, divested of those minute details with which it is less important he should be acquainted. We should be pleased to follow him through this examination, but our limits will not admit, nor is it necessary we should do so, as we do not meet with any thing important which is not contained in most of the works on general anatomy. The subject of general anthropotomy is concluded by some very interesting remarks relative to the symmetry of the organs, and the relations between one side of the body and the other. We must, however, pass them over to examine the subject of

Anthropo-Chemistry.—The subject of animal chemistry is one of much importance to the physiologist and pathologist, yet it is encumbered with so many difficulties, that notwithstanding the numerous

efforts which have been made to illustrate its principles, we possess but very imperfect and unsatisfactory information relative to their details.

Of the ultimate chemical elements of the solids and fluids of the body, we know but little. It is however highly probable that they are not numerous, and that the several modifications observed in the composition of the different parts, are altogether ascribable to the different proportions in which they combine with each other. The following are given by Professor Rudolphi as the principal simple chemical elements which enter into the organization of the human body: "oxygen, hydrogen, nitrogen, sulphur, phosphorus, carbon, iron, sodium, potassium, calcium, talcium or magnesium, and chlorine." To this list, others might doubtless be added, amongst which we may mention silicon, fluorine, &c. the last of which, in form of fluoric acid, exists in small quantity in combination with lime, in the enamel of the teeth.

These elements do not exist in the same proportion, a few of them constituting the greater part of the materials of the organization, while others only form a very small part. By their several combinations, however, several proximate principles are formed, which, by the variable proportions in which they exist in the solids and fluids, serve to impress upon them numerous modifications. These general organic elements are, according to our author; "gelatine, albumen, fibrine, mucus, serum, adeps, and lactic acid, the last, according to Berzelius, (Djurkemie, I. 480,) constituting a part of the solids and fluids, in which it exists in either a free or combined state, especially in the blood, urine, milk, marrow, and even the muscles."

The observations on the subject of animal chemistry are highly interesting, and are drawn from the researches of the latest authors, especially from those of John and Berzelius, whose authority on these subjects is superior to that of any others. The same observations will apply to the next subject brought under discussion; the general character of the compound materials formed by the assemblage of those just enumerated, as the "blood, lymph, membranes, hair and nails, cartilages, bones, fibrous tissues, muscles and nerves," the chemical characters of each of which are examined with much attention and ability. We must, however, pass over all these considerations to topics of a more interesting character. The next subject, therefore, that we shall examine, is

The general Chemical phenomena which take place in the Human Body.—"The general chemical changes incessantly going

forward in our organs, give rise to many phenomena, which are so strongly marked, that we might, on a superficial examination, be induced to regard them as a portion of the organization itself, rather than the product of a general chemical process. It is from this cause that the organized solids have been supposed to be blended with certain imponderable substances, as caloric, (thermogenium,) light, (photogenium,) and electricity, (elcetrogenium.")

"Heat," continues our author, "seems to be a property common to all organized bodies, without exception; in plants, however, it is so fluctuating, and so much under the influence of the temperature of the atmosphere, that some naturalists, amongst whom may be mentioned Nau and Treviranus, have denied that it appertains to vegetables. But the observations of Hunter, Schöpf, Solomè, and Hermstädt, seem to prove beyond contradiction that it does appertain to vegetable as well as to animal life. If, in the midst of winter, the trunk and roots of a tree do not present any difference in their temperature from the atmosphere, we find the same thing in some animals, which spend a part of their time in a state of torpidity, in which frequently no traces of animal heat can be detected, while they remain in this quiescent and passive state of existence. We moreover find vegetables endowed, in a high degree, with the faculty of resisting the influence of the temperature of the atmosphere—a property which is in proportion to their vigour, and which is extinguished with their death.

"Some plants generate a considerable quantity of heat during the act of efflorescence—a fact which was first observed by Lamarck, in the *Arum italicum*. Huber, moreover, instituted an extensive series of experiments, in the Isle of Bourbon, upon the *Arum cordifolium*, from which he discovered that the spadices, when the temperature of the atmosphere was 21° Reaumur, generated a temperature of 45° Reaumur. The same thing was observed by Bory de St. Vincent to take place in the *Arum esculentium*."

Animals possess the faculty of generating heat in very different degrees. The *vermes*, of Linnæus, crustacea, a part of the insect tribe, the fish and amphibiæ, only possess it in a very feeble degree. The more perfect insects, the mammalia and birds, have it very strongly developed, and in man it is as great as in the largest land mammalia.

Of these, the intestinal worms especially manifest a great dependance upon the surrounding medium for their temperature. Hence it is we frequently find, that when exposed to cold water, these animals become at once torpid, and evince no signs of life; a condition, however, from which they may be again resuscitated by exposing them to a little warm water. It has, moreover, been observed by Professor Rudolphi, *(Historia Entozoorum Anat.* 1809, *Tom.* 2,) that they often assume this torpid state after the death of the animals which they inhabit. Yet, however much such animals are dependant upon the medium in which they lived, they possess, within themselves, a

power of maintaining, for a time, a temperature above that which surrounds them. Hunter put some earth-worms into a glass vessel, when the temperature of the atmosphere was 56° Fahr. and, placing the thermometer amongst them, he found that the mercury rose to 58½°, showing a difference of two degrees and a half, *(Animal Œcon.* p. 117.) In the crustacea this difference is much more considerable. In the common crab, *(Astacus fluviatilis,)* Professor Rudolphi found, that the thermometer placed between the muscles of the tail, indicated a temperature of 10° Reaumur, that of the apartment being only 5°. In the fish it presents a considerable variety, being lower in some than that of the water, while in others it is several degrees higher. It is related in the voyage of Verdun, Borda, and Pingre, Paris, 1778, that the thermometer, placed in the stomach of a living stock-fish, indicated a temperature of 5⅓°, at the same time that another, placed in the open air, stood at 11°. (Treviranus, Biologie, band. 5.) Perrin, however, found the stomach of the Raja to present a temperature of 22°, when that of the water was only 19⅘°, and results, differing only in degree, have been obtained by others. In the *Torpedo marmorata*, Professor Rudolphi observed that the thermometer, placed in the pericardium, stood at 18½°, while the temperature of the water was 18°, therefore indicating but a very trifling difference in the heat of the animal and the medium in which it lived. In the frog and land turtle, according to Martine, the internal temperature is greater by 5° than the surrounding medium; and Hunter, Krafft, and others, have observed a difference equally striking in the Cyprinus, Raja, &c. (Treviranus, Biologie, Band. 5. p. 25.)

The birds possess this faculty of generating animal heat in a much higher degree. In this respect, indeed, they must be placed above the mammalia, as many of these indicate a temperature considerably above that attained by even the largest animals. The ordinary temperature of man is 96° Fahr. or 28° Reaumur, and in dogs, cats, sheep, bullocks, and hogs, it was found by Martine to vary from 30⅔° Reaumur, to 30⅘°, which is probably the highest temperature presented by the mammalia. In the birds, however, it was found by Pallas to be considerably greater. On a warm day, in July, the lowest temperature observed by him, was 31⅘°; the highest, 35⅘° Reaumur, or 111° Fahr. Thus, in "the *Vultur barbatus*, it was 33⅘°; *Falco ossifragus*, 32⅔°; *Nisus*, 33⅓°; *Lanarus*, 34⅓°; *Palumbarus*, 34⅘°; *Fringilla arctica*, 35⅔°; and the same in the *F. linaria*, the *Parus major*, and the *Hirudo lagopus*, &c."

But while this character appertains to all animals in common, from the highest to the lowest, it does not, as has been already shown,

exhibit the same regularity throughout. The lower orders, in which animal heat is but sparingly generated, it has been seen, are indebted, to a certain extent, for their temperature, to the medium in which they subsist. In man, however, this law does not hold good, inasmuch as when in a state of health he preserves the same temperature in every climate, and under every sky—as well under the heat of summer, as the frosts of winter—the parchingtsun of the torrid zone, and the eternal snows of the arctic regions. Under all these circumstances, and in all these situations, the thermometer placed in the mouth constantly indicates a temperature of 29 to 29½° Reaumur.

This circumstance clearly proves his independence of surrounding circumstances for the warmth which enlivens and invigorates his several organs, and that it owes its origin to some change, either chemical or vital, constantly going forward in the organization.

These considerations naturally lead us to inquire into the sources of animal heat—a question upon which physiologists have been much divided in sentiment, and which still remains undetermined. Professor Rudolphi only considers the subject in a cursory manner in the first volume, leaving the principal details to be examined in connexion with the fuoction of respiration. He seems to think that it owes its origin "to changes taking place in the materials of the organization, occurriog for the most part within the cavity of the thorax, and that it is in no manner dependent upon nervous influence." In opposition to the opinion which refers the generation of animal heat to the agency of the nervous system, he adduces the following arguments, which, it must be confessed, have much weight, yet we do not consider them conclusive:—

"That there is no relation between the nervous system in different animals and their temperature; that if this were the case, man should present the highest degree of animal heat, because his nervous system presents the greatest degree of development. The mammalia should, for the same reason, present more than the birds, these but little more than the amphibiæ, and the inseets should have a temperature far below that of the fish, which does not hold good in any one of the instanees addueed."

The author next makes some observations upon the electric faculty, possessed by some aoimals, which, though interestiog, we cannot here detail: the description of the apparatus by which they are enabled to exercise this wonderful power, will be found in the Periscope, department Anatomy.

The fourth book treats of the subject of *Zoonomia.* By this term our author implies the general manifestations of life, and its several modifications, or properties.

All organized bodies, whether animal or vegetable, are endowed with one fundamental property, which appertains to them in common: incitability, (erregbarkeit,) or the power of acting under the empire of stimuli, and thus giving rise to reaction, incitation, or excitement. But while this incitability is common to the entire organization, it bears different appellations, according to the particular tissue in which it is manifested. Thus, in the membranes, it is called contractibility, in the muscles irritability, in the nerves sensibility, &c. These several properties, which have been by some considered as altogether distinct, merely imply a susceptibility to be impressed by external agents, or as it has been expressed by some physiologists, a state of receptivity, which must be distinguished from the "*vis Psychica,*" or that power which impresses upon the organization this receptivity, and which is the vital principle itself, of which we know nothing, except from its effects, but which must not be confounded with the nervous power, notwithstanding it approaches nearer that principle, as Professor Rudolphi correctly observes, than to any of the other properties of the organization.

Part II. *Special Physiology.*—After passing in review the several subjects which appertain to general physiology, Professor Rudolphi enters upon the consideration of the special details of the science. This forms the commencement of the second volume, which we shall next proceed to examine, in the order pursued by the author himself, commencing first with the nervous system. This, according to him, consists, "on the one hand, of the great central organ of the nervous system, or the greater and lesser brain, and the spinal marrow, and on the other, of the nerves which are intimately connected with the parts just mentioned."

The central part of the nervous system is more strongly developed in man than in animals, while the nerves are small in comparison to the brain and spinal marrow. But it is not only in the relations between the brain and nerves that we perceive this difference: if we examine the proportions between different parts of the brain and spinal marrow, we shall find them exhibiting varieties which are almost endless as regards their comparative development. In man, the cerebrum is voluminous, and is well developed in every direction—in height, as well as in its transverse and longitudinal diameters, while the cerebellum is comparatively small. The anterior part of the cerebrum is also much fuller and more prominent in man than in animals, while in the latter the cerebellum is the part which presents the preponderance of volume, compared to the proportions existing between the other portions of the brain. It is this full development

of the anterior lobes of the brain which imparts to man his noble and intellectual forehead, his commanding facial angle, and lofty air of contemplation divine, while in animals we find the forehead low and retreating, and the facial angle consequently diminishing, in proportion to their degradation in the scale of beings. In applying these principles, however, care must be taken not to confound the development of the cranium with that of the brain, inasmuch as in many animals the frontal sinuses are so full as to convey the appearance of a full and rounded forehead, when, in reality, the corresponding portion of the brain is small. In many of the birds, moreover, the air-cells, which exist so abundantly in the cranial bones, impart to some portions of the head a degree of prominence, which is by no means in relation with the corresponding lobes or convolutions of the brain. The greater development of this organ in man than in animals, gives rise to a proportionate preponderance of volume, or rather extent, of the corpus callosum, while its greater height removes this body more from the upper surface of the organ, and consequently leaves a greater extent of the two hemispheres to be separated by the falx.

As regards the arrangement of the medullary and cortical substance, of which the brain is composed, our author does not entirely agree with Gall and Spurzheim, nor does he concur with Treviranus in believing in the existence of laminæ interposed between these two substances. In the first place, our author maintains, contrary to the assertion of Gall, that the convolutions are merely formed by the pia mater penetrating the substance of the brain in company with the vessels—a sentiment which has also been adopted by Professor Tiedemann, of Heidelberg, and against which we cannot perceive any very conclusive objection. But when he objects to the conclusion of Gall and Spurzheim, that the brain may be unfolded so as to represent a kind of membranous sac, he is incontestibly in error. "I have attempted," says he, "by all the means indicated by Gall, to effect this unfolding of the brain, but have always found that it could not be accomplished except by violently lacerating the parts, and that the convolutions can never be unfolded in a natural manner, as he pretends." In reply to this, we think we may, with Dr. Gall, apply to our author the language of Vicq d'Azyr, "that to observe correctly in anatomy, something more is requisite than eyes." We consider it our good fortune, that in 1825 we had an opportunity of witnessing at Paris several dissections of the brain made by Dr. Spurzheim, in which he succeeded in this act of unfolding the organ to our entire satisfaction. Since that time we have perhaps examined more than a hundred brains, partly with that view, and whether we owe it

to the excellent instructions which we received, or to some other cause, certain it is, that we have been more successful than Professor Rudolphi, and have been seldom disappointed in our attempts when the organ has been in good condition, and we have went to work with sufficient patience.

The following is our author's description of the order in which the medullary fibres expand to form the brain.

"From the spinal marrow they pass in several directions to the pons varolii, from whence they extend into the thalami, the corpora striata, and the lateral masses of the cerebrum, into which the horizontal fibres of corpus callosum also extend; and from the lower face of this, the laminæ which form the septum lucidum descend to the fornix, which latter forms numerous connexions with the other parts of the brain, by means of its several appendages or limbs, (schenkeln.) If we unfold the cerebellum, which is peculiar in its formation, we shall find that it is composed of several transverse fibres from the pons varolii, of other fibres from the spinal marrow, and is connected with the cerebrum by means of fibres and laminæ. Finally, if we examine the tubercula quadrigemina, and their dependancies, the pineal gland, with its prolongations, the appendage of the cerebrum, &c. we shall observe an interlacing of fibres which authorizes us in awaiting further proof before we can conclude that they never take any other direction. This arrangement, moreover, furnishes a strong argument in favour of the unity of the brain."

With regard to the manner in which the nervous filaments derive their origin from the substance of the brain and spinal marrow, Professor Rudolphi correctly observes, that we know nothing positive. It is true, that by diligent researches made upon fresh brains, or those which have been hardened by alcohol, or otherwise, we can trace the nervous filaments emerging, as it were, from the substance of the organ, yet we are unable to determine whether they are directly continuous with the medullary fibres of the brain, or whether they take their origin from the cortical substance, or ganglions, as maintained by Gall. The latter opinion he considers the most rational, because it comports better with what is observed in the nervous ganglions, in which we find a free communication established between several nerves, without there being any direct anastomoses between their different filaments.

By Reil, it was supposed, that the peripheric extremities of the nerves terminate in the substance of the tissues, by free ends, or a free substance; by Prochaska, that the nervous substance becomes blended as it were with the other materials of the organization, thus adapting them to the reception of impressions, while our author, from the result of numerous researches, concludes, that neither of these opinions are correct—

"That the nerves no where end in vessels, that the nervous matter never becomes blended with that of the muscles, glands, &c. but that the minute filaments branch out in such a manner as to form a delicate plexus around the muscular fibres, vessels, and other parts which they are destined to supply."

This view of the subject, we think, is very plausible, and is well exemplified in the distribution of the nerves in the tongue, the substance of the heart, and the larger muscles.

There yet remains one question to be solved relative to the connexion between the brain and spinal marrow and the nerves. Are the latter composed of two orders of filaments, one passing from the brain and spinal marrow to the periphery of the system, and the other in a contrary direction? There is nothing appreciable in the anatomical arrangement of the parts to warrant such a conclusion, and it cannot be allowed to have any other foundation than mere conjecture, however well it may seem to comport with the functions performed by the nervous system. But be this as it may, certain it is, that there are two orders of nervous filaments, the one subservient to sensation, the other to motion. This fact, lately established beyond all power of contradiction, by the researches of Charles Bell, Magendie, &c. was known, or at least spoken of by Galen. He did not, however, locate these different offices in separate filaments of the same nerve, but supposed that the nerves which possess a soft texture perform the office of sensation, while those which are firm and compact in their arrangement, preside over the function of motion. In many of the anatomical writings subsequent to those of Galen, we find direct reference made to the existence of sensorial and motory filaments in the same nerve, and this, too, in modern times, by authors with whose writings Mr. Charles Bell should have been familiar. Thus, Prochaska, in speaking of the division of the nerves into those of sense and those of motion, observes, "Hæc divisio recte in usu nervorum fundata est, quanquam inde minime sequatur nervos sensorios aliter fabricatos esse, quam sint motorii, & quanquam in unico sæpe funiculo nerveo utrumque nervorum genus tam sensorium quam motorium & hoc voluntarium non minus quam involuntarium ligata esse reperias." (Tractatus de Struct. Nervorum, Vindobonæ, 1779, p. 47.) But although this doctrine had been inculcated by a number of celebrated anatomists from the time of Galen, it had never been properly understood, before it was fully established and illustrated by Bell and Magendie.

Less difficulty exists in determining the relations between the brain and spinal marrow, though the facts are not sufficient to authorize us in concluding, with many of the most respectable anatomists of the present day, that the spinal marrow is formed first, and that the brain

should be considered merely as an efflorescence of that body. True it is, that as represented by Serres, in the four classes of vertebrated animals, the spinal marrow is formed prior to the brain, yet this by no means proves the validity of the assumption to which we have adverted; for although the brain may not be visible at this early period, it is nevertheless probable that it exists in a rudimentary state, otherwise we could not account for the development of that organ, in those cases of monstrosity in which the spinal marrow does not exist, instances of which are on record.

With regard to the vital properties of the nervous system, there has ever existed much difference of opinion, some referring all its operations to a mechanism similar to the vibrations of a tense chord; others, to the agency of a peculiar fluid, or nervous æther; others, to a kind of oscillatory motion performed by the elastic globules of which the brain and nerves are composed. These views, however, are irreconcileable with the known laws of the animal economy, and cannot be admitted in explanation of the phenomena in question. Indeed could we reconcile the operations of the nervous system with the agency of this oscillatory motion, the nervous æther, or these vibratory actions, we do not find it requisite to call to our aid the influence of such properties; for the nervous system, we must regard as a portion of the organization, endowed with certain properties capable of being influenced by particular laws, and obedient to the impression of stimuli, in the same manner that the entire organization is influenced. It is, then, to the operation of this nervous matter, under the influence of stimuli, that we must ascribe the whole phenomena of innervation, sensation, and the other manifestations to which the nervous system gives rise. But these operations are not every where the same. They seem to be most forcibly developed in the central part of the nervous system, while their manifestations or influence are conveyed to the peripheric portion, by means of the nerves which act as faithful conductors. This is proved by the influence of ligatures, compression, the division of a nerve, &c. which is always followed by the paralysis of the part to which such nerve is distributed. From this apparent conducting property of the nerves, and the interruption of the phenomena of innervation which succeeds their division, an identity has been inferred between the nervous and galvanic fluids. This hypothesis has been strenuously advocated by Wilson Philip, and several other distinguished physiologists. It has been alleged in support of it, that the galvanic fluid, when passed along a nerve thus divided, possesses the power of restoring the action of a part which has been paralyzed by its division, even though

the ends be separated from each other. Humboldt and Reil long since offered an explanation of this conducting power of the nerves, when interrupted in the manner pointed out, the former attributing it to a kind of nervous atmosphere, *(atmosphera nervorum sensibilis,)* which he conceived might extend five-fourths of a line from the nerve itself; the latter to the property which he supposed the nerve to possess, of communicating its properties to the parts in its vicinity. These conclusions are, however, erroneous. The nervous atmosphere imagined by Humboldt, and subsequently by Carus, does not exist, nor does the faculty of the nerve extend to the other parts, further than the nervous matter itself exists in their substance. The experiments of Wilson Philip do not prove an identity between the galvanic and nervous fluids, inasmuch as that principle can pass along any substance which is a good conductor, and when extended in this manner to the *distal* extremity of the divided nerve, it excites it in the same manner, and in virtue of the same law, that any powerful stimulus excites the living solids. This is a legitimate conclusion from the experiments of Breschet and Milne Edwards, and comports better with reason and known principles, than the hypothesis of Wilson Philip. If it were owing to the agency of a nervous atmosphere as represented by Humboldt and Carus, it would not be interrupted by placing the parts upon a non-conductor, as for instance, a plate of glass, as was done in the experiments of Weinhold, (Versuche ueber des Leben,) because this nervous atmosphere would still prove efficient, even under these circumstances.

The brain, which we have said constitutes a portion of the great centre of the nervous system, is the seat of all intelligence: it receives all impressions which are made upon the sentient extremities of the nerves, and by a reflex operation, developes, controuls, and regulates all our thoughts, volitions, and actions. It therefore constitutes the great throne of the human mind, that noble prerogative by which man is ennobled above all earthly beings, and made to approximate in the power, extent, and versatility of his understanding, the angels of heaven.

> Os homini sublime dedit, cælumque tueri
> Jussit, et erectos ad sidera tollere vultus.

But in entering upon the investigation of this noblest of all human faculties, we are met by a question which has somewhat puzzled philosophers from the earliest period to the present time: is this important, this faculty almost superhuman, located in the entire brain, or is it the manifestation of some one of its parts? The older philoso-

phers, adopting the latter conclusion, were much busied in seeking out the locality of the mind or soul. Some supposed it to be placed in the fornix, some in the pineal gland, others in the corpus callosum, and even more recently, Soemmering has referred it to the ventricles of the brain. Such conclusions are altogether preposterous, and are undeserving any serious consideration. Mind we are disposed to regard as merely consisting of an assemblage of manifestations emanating from the action of the brain. When, therefore, it is taken as a whole, it does not arise from the activity of any one particular part or portion of that organ, but from all its parts collectively. This, however, is not true of the individual manifestations themselves, for each part or manifestation of which the mind is composed, owes its origin to some particular portion of the brain, the special province of which is to give rise to it. While, therefore, the mind in a state of unity, is considered as emanating from the activity of the entire organ, its individual manifestations must be referred to the activity of some one of the parts of the organ, in the same manner that the entire alimentary canal is subservient to the process of digestion, while its different portions perform particular parts of that process; as, for example, the stomach the process of chymification; the duodenum the elaboration of chyle; while the large intestines perform the office of defecation. If this view of the subject be correct, (and that it is, we think cannot be denied,) how can we, with the metaphysicians, reject the doctrine of the plurality of faculties? Are we not led naturally and irresistibly to the adoption of the tenets of Gall and Spurzheim, according to which the mind is made up of an assemblage of faculties, all having their special localities in the brain, and each bearing a constant relation between its degree of development and the activity of the manifestation to which it gives rise? Such at least are the conclusions, which, from the facts adduced by them, as well as from our own observations and reflexions, we are constrained to adopt. Yet we are sorry that in this we are obliged to differ in opinion from such respectable authority as that of Professor Rudolphi, who seems to be strenuously anti-phrenological in his opinions. Let us examine the force of the arguments which he has opposed to those of Gall and Spurzheim, and see how far they are entitled to our confidence. Professor Rudolphi seems to think, (p. 38, vol. 2,) that Gall should be able, if his doctrines were well founded, to determine the functions of the different parts of the brain, merely by the inspection of isolated fragments of the organ in which those faculties are located; and he even asks the question of his ability to do so, and then urges its impossibility as an argument against the truth of his doctrines of the plu-

rality of faculties. In reply, we will ask Professor Rudolphi, if he can determine, by mere inspection, what portion of the filaments of which a nerve is composed, presides over the function of sensation, and what over motion? If he were shown an isolated fragment of the optic nerve, and another of the nerve of taste, or hearing, could he designate, by mere inspection, which was subservient to the one, and which to the other of these functions? We maintain that he could not. With a parity of reasoning, therefore, we might deny, that these nerves perform different offices, as he has declared that the brain cannot consist of a plurality of faculties, because we are unable, merely by the examination of an isolated fragment of the organ to decide what faculty it subserves.

Our author attempts to controvert the several anatomical and physiological arguments, which have been adduced by GALL, in support of his opinions.

"The brain," says he, "is affirmed by Gall to be less complicated in animals than in man, and that in the former the anterior and lateral portions of the cerebrum are defective." "In the mammalia," continues he, "the brain is as complex as in man, and possess the same parts. As to the convolutions, they are wanting in the human embryo, as well as in many of the inferior animals."

It is true, that in the mammalia we meet with all the parts which contribute to the formation of the human brain, but this by no means militates against the opinion of Gall, nor does it tend, in the slightest degree, to substantiate the objections to those opinions advanced by our author. Will he, or any other anatomist, affirm, that these parts present the same relative development? And will he not admit, that throughout the whole class, there is an unvarying proportion between the organization or development of the different parts of the brain, and the instinctive or intellectual manifestations? Do we not, in effect, find in man, the anterior lobes of the brain more developed, than in any of the mammalia? and do we not, in him, find an intellectual supremacy proportionate to the full development of this part of the organ? Do we not find, in animals, other portions of the same organs exhibiting a preponderance of development, and do we not, in them, observe a preponderance in the power, or manifestations of a corresponding faculty, or sentiment? How, then, can we believe that these manifestations are equally the result of the activity of the whole brain? If that were the case, the modifications in question could not take place. According to the views of Professor Rudolphi, quantity of cerebral matter being all that is requisite, the temperament being the same in two individuals having the same quantity of brain, the intellectual and moral manifestations should be the

same, whether most of this matter occupies the anterior, posterior, or middle lobes of the brain. Will any one, who is conversant with the structure of the brain, and who has attended to its manifestations, tell us this is the case? Such an assertion would be at variance with facts which are visible to every one who carefully observes the phenomena of the intellectual, or instinctive operations of all sensible beings. But to render still more palpable the defects of the author, let us turn our attention to the three inferior classes of vertebrated animals; the birds, the reptiles, and the fish. We no sooner pass the limits of the mammalia, than we find a gradual falling off in the perfection, or complexity of the brain. In the birds, some of the parts of that organ are wanting, which exist in the mammalia, and a great deficiency of development is observed in others. As we descend still lower in the scale of beings, we find a gradual declension in the perfection of the organization, and this is every where observed to bear a constant relation with the decline of the intellectual powers. These are not mere assertions:—they are facts, which rest upon the respectable authority of Vicq d'Azyr, Cuvier, Tiedemann, Carus, Serres, and, indeed, every one who has dissected the brains of animals with attention, and cannot, and will not be disputed by Professor Rudolphi himself. If then, it be admitted, that there exists a constant relation between the development of a particular portion of the brain, and the manifestation of a particular faculty, or sentiment, we are constrained to admit the existence of a plurality of faculties, and to deny that the manifestations of the several faculties or sentiments, take place indifferently from any part of the brain, or from the entire organ. Professor Rudolphi has himself, in another paragraph, admitted this conclusion, p. 41. He observes—

"There is a constant relation between the different parts of the brain, and the external senses, and it is also demonstrated, that the optic couches, the striated bodies, together with the anterior part of the tubercula quadrigemina, constitute the organ of vision; the olfactory bulbs, or rather the anterior inferior convolutions, the organs of smell; and the walls of the fourth ventricle, the origin of the auditory nerve," or the organ of audition. "An injury of the upper part of the brain occasions paralysis of the opposite side of the body; and a wound of the pons varolii destroys harmony between the anterior and posterior part of the brain."

Here, then, we have an acknowledgement, that different portions of the brain are endowed with separate properties, or perform different offices, yet we are told, that the organ is an unit; that its faculties are likewise an unit, and that volume is all that is requisite to ensure the most active and diversified qualities. A Cæsar, or a

Bonaparte—a Homer, a Shakspeare, or a Milton—a Newton, a Kant, or a Bacon, and volume alone distinguishes such immortal characters, from the thousand abject wretches, who are annually brought to the gibbet, or the stake, for the perpetration of the bloodiest crimes. By those who admit such philosophy as this, it might well be said, that the mind of a Newton would have exhibited the same powers, in the brain of a frog, as in its own native habitation divine.

Professor Rudolphi has also objected to the physiological inferences of Gall: 1st. That the different instincts and faculties require separate organs: 2d. That some animals are endowed with certain qualities, or faculties, of which others are deprived: 3d. That these faculties, which exist in all individuals of the same species, exhibit a great disparity in their degrees of activity: 4th. That in some individuals, the several primitive and fundamental qualities exist in different degrees, which could not be the case, if each primitive quality did not depend upon a special organ: 5th. That functions of the brain, essentially different, are not simultaneously manifested, either in man or animals:—some of them are manifested at all times, while others only show themselves, or cease to exist at particular periods of life, or at certain seasons. This is incompatible with the supposition, that all are dependent upon one homogeneous organ, the faculties of which are an unit: 6th. And lastly, that the continued application of the mind does not fatigue, in an equal degree, all the intellectual faculties: the principal fatigue is so far only partial in its influence, that we can restore the impaired energy, even while the mind is actively employed, provided we change the object. This could not be effected, if the entire brain were equally employed in the mental effort. Against these several propositions, he has detailed his objections. They, however, appear to us altogether too feeble and unsatisfactory to carry conviction: at least, upon our mind, they have not produced that effect, and we are free to confess, that we consider Gall's rejoinder* a complete refutation of all that has been urged by Professor Rudolphi, against his principles.

Against the first proposition laid down by Gall, he urges, that "a brain large in proportion to the nerves, therefore constituting a more powerful apparatus," is sufficient to account for the phenomena in question; consequently, there can be no necessity for supposing the existence of a separate organ for each sentiment, or faculty. Unfortunately for the validity of this assumption, we well know, that a

* Sur les fonctions de Cerveau. Tome VI. Paris, 1825.

large brain is not all that is requisite to ensure the active manifestation of all the faculties; for if in two animals, having brains of eqnal magnitude, we shall find that their several parts do not bear an accurate relation to each other, one perhaps, being largely developed at its posterior, the other at its anterior part, and in proportion as tho one or the other of these conditions holds good, we shall observe a corresponding preponderance of the manifestations of the sentiments, or the intellectual faculties. The truth of this proposition is well exemplified in the elephant, and some other animals.

To the second proposition, our author objects, "that these separate parts, or organs, cannot be demonstrated, and admitting them to exist, the animal could not be changed by education." In reply to this, Gall has observed—

"If he will examine the brain of a dog and a cat, he will find a difference in the number, as well as in the arrangement of the convolutions:—if he will compare the middle lobe of the brain of an ox, with the same part of that of a dog, or a tiger—the brain of the common hen, with that of a crow—of the pidgeon with that of the sparrow-hawk, and does not, throughout, find a material cause in the arrangement of the brain, of the difference of their instincts—if comparative anatomy does not every where reveal to him a difference in the brain, corresponding with the difference of their qualities, I will console myself for his blindness by exclaiming '*non omnes omnis possumus.*'" (Fonct. de Cerveau, Tome VI. p. 133.

Professor Rudolphi has also objected to the fourth proposition of Gall, which, he says, is not well-founded; for, according to his views—

"Whoever possesses a pre-eminent genius, as for instance Goethe, succeeds perfectly in every enterprize to which he devotes himself with ardour, whereas, an individual with a weak intellect, does not succeed well in any thing he undertakes. We often hear of great musicians, who are very much limited in their other capacities; but they who are remarkable for this faculty of music, are not, in reality, deficient in other respects, since they only live as it were, for their art, and neglect to improve themselves in all other pursuits. The sharper considers all others foolish, or imbecile, because they do not avail themselves of his cunning, or neglect to appreciate it." (Vol. II. p. 40.)

We are at a loss to comprehend how Professor Rudolphi, with the experience of ages before him, and the whole mass of authority against his assumptions, could advance opinions so palpably erroneous. If a man should be so fortunate, according to the principles here inculcated, to possess one intellectual character in an eminent degree, he is to be at once considered as an universal genius, capable of the most glorious and diversified mental achievement of triumphing over every difficulty; of fathoming the most abstruse mysteries of religion

and philosophy. and excelling alike in every capacity. By this rule, a HANDEL, or a MOZART, might be a HOMER, or a NEWTON. Mere chance could have transformed a GALILEO into a KANT, or a LOCKE—a DANTE, or a MILTON, or a PETRARCH, into a CÆSAR, or NAPOLEON, or the latter into a HEYNE, a WOLFF, or a PARR!! Intellectual supremacy, in any department, would be accidental, and a RAPHAEL, and LEONARDI DE VINCI, could have as easily immortalized their names by diving into the mazes of metaphysics, or inditing love sonnets, as by wielding the palet and brush, and imparting life, love, and beauty to the inanimate canvass. Our author should have recollected that "*Poeta nascitur, non fit,*" as all experience has shown, that without this inheritance from nature, it will be vain to aspire to supremacy in any intellectual pursuit.

These will serve as specimens of the arguments addueed by Professor Rudolphi, against the plurality of the faculties of the mind, and the propositions of Gall, upon which, that doctrine is sustained. It is needless we should state, after the observations already made, that we consider them by no means satisfactory, or conclusive. We, therefore, deem it an act of supererogation to follow him further in his objections, since those he has urged against the fifth and sixth propositions, are even more futile than those which have been detailed. The doctrines of phrenology are fortified by too great a mass of important facts—are too much in accordance with reason and common sense, the known laws of the organization, and the manifestations of mind, to be shaken by the empty cant, and frivolous sophistry, by which it has been assailed, and he who wishes to controvert them, must appeal to more efficient instruments of combat.

From the consideration of the intellectual operations, we shall pass with our author to the examination of the subject of sensation. The sensibility with which any part of the body is endowed, is owing to the nerves distributed to it; and its degree will, consequently, depend upon their number and volume. It is for this reason that we find such a diversity in the powers of sensibility possessed by the different tissues, some being endowed with that property in a high degree, while others possess it so sparingly, that it can scarcely be said to exist: of the latter class, are the hair, epidermis, nails, bones, cartilages, ligaments, tendons, and serous membranes, into which no nerves penetrate, except some very minute filaments which accompany the vessels. Next in the order of their powers of sensibility comes "the vessels and some of the glands, the thyroid gland and spleen, the liver, lungs, kidneys, and testicles; and

in a still higher degree the alimentary canal, the skin, muscles, and, last of all, the external senses." (Vol. II. p. 53.)

This sensibility is liable, however, to be very much modified by disease, and a circumstance somewhat strange is here observed—that these modifications are not regulated by the number and magnitude of the nerves. Thus, we frequently find those parts, which are most obscure in their manifestations of sensibility, becoming exquisitely painful under the influence of disease.

The nervous system, constituting the proper apparatus of sensation, is endowed with a peculiar power of receptivity, or sensibility, which, when acted upon by its appropriate agents, gives rise to the phenomena of sensation, which must be considered according as it affects the nervous system in general, (sensatio, aesthesis,) or particular parts or apparatus of it, as the five senses—touch, taste, smell, hearing, and sight. The phenomena of general sensation must, moreover, be divided according as they consist of the reception of the impression by the nerves themselves, and its extension to the brain, and its communication from this latter organ to the muscles, thus giving rise to volition. The sensations are variously modified by circumstances, and differ in their manifestations according to their intensity, duration, the state of the body, and the parts in which they are excited. In consequence of the extensive chain of sympathies possessed by some organs, impressions made upon them give rise to a much more extensive range of sensations than impressions made upon parts not thus endowed. We cannot, however, enter into any considerations upon the laws of sympathy relative to which our author's remarks are very sensible.

The whole surface of the body is more or less tactile, at least all those parts which are endowed with sensibility, yet some portions of the skin possess this faculty in a much more exquisite degree than others, and are accompanied with an arrangement of the other structures calculated to render the faculty extensively available. This is especially the case with

"The upper extremities which have the tips and inner surface of the fingers beset with numerous delicate papillæ abundantly supplied with a tissue of vessels and nerves, while on the back part of the last phalanx, the existence of the nails divests them of the faculty of touch. The great mobility of the shoulder joint and fingers, moreover, furnishes a great facility for the ready application of one hand, and still more both, to objects, and bringing them in relation with all their parts, so as to enable us to determine the figure and arrangement of their surface, as well as whether they are hard, smooth, or beset with asperities."

The arrangement of the elbow-joint enables us, at the same time, to estimate the distance of objects, and when taken in conjunction with the numerous articulations of the fingers, which accommodate themselves with great readiness to small bodies, furnishes an excellent means of determining their relations with each other. All these circumstances render the sense of touch one of great importance to man, so much so, indeed, that it has sometimes happened, when individuals have been deprived of the powers of vision, their tactile powers have become refined to such a degree, as to become a tolerable substitute for the lost faculty. Cases have been reported in which the sense of touch was so delicate in blind persons, as to enable them by its agency to distinguish colours.

In animals it only affords a very limited resource. Even in the monkey, the fingers are so small, and the nails so much curved, as to furnish an arrangement very unfavourable for the exercise of this faculty; and the difficulties are still further augmented by the shortness of the thumb, and the confined motions of the shoulder-joint, which, in consequence of the upper extremities being used for the purposes of progression, does not allow of the same latitude of motion as in man. It is for these reasons that animals seldom employ the sense of touch, but trust for the most part to those of smell, sight, and taste. The trunk of the elephant, though apparently employed by that animal as an organ of touch, is destined more, Professor Rudolphi thinks, as a substitute for the shortness of its neck, and as an organ of prehension; and those mammalia which employ their fore-feet as hands, use them more for the purpose of seizing and holding objects, than that of determining their characters. Of still less value, as organs of touch, are the nose-bristles, or palpi, *(mystaccs,)* of animals of prey, as tigers, lions, cats, &c. But in consequence of their great length and mobility, they serve as a medium by which the skin, as an organ of touch, can be brought in relation with surrounding objects. "Vrolik, (Over-het nut der knevels ley viervoetige dieren. Amst. 1800,) found, that a dog that had been deprived of these hairs, and blindfolded, could not find his way through a narrow passage, and that a cat, similarly situated, could no longer catch mice." These hairs, therefore, serves as feelers, by which the animals possessing them are directed in the dark in search of their prey, but never as organs of touch in the true sense of the word. The same thing may be said of the filaments, which are attached to the head of some fish, *(Lophius, Silurus, &c.)* of the antennæ and palpi of insects, the tentacula of the molusca, &c.

The sense of taste ministers largely to our pleasures, at the same

time that it, to a certain degree, protects us against many sources of danger. The organ in which this important faculty is located, is the tongue, composed of an assemblage of muscular fibres variously blended together, and abundantly supplied with nerves, over which is expanded the mucous membrane of the mouth. The nerves distributed to this organ, are the hypoglossus, the lingualis, or third branch of the fifth pair, and the glosso-pharyngeal. Of these, the first is spent upon the muscles, the second, for the most part, upon the three orders of smaller papillæ, with which the tongue is beset upon its upper surface, viz. papillæ filiformis, conicæ, fungiformes s. capitatæ; and the third, upon the large papillæ, (papillæ vallatæ.) There has, however, existed some difference of opinion relative to the ultimate distribution of these nerves, and especially with regard to the offices which they perform. Cuvier, (Leçons d'Anatomie Comparée, Tome II. p. 697,) observes, that "from the frequent anastomoses between the fifth and ninth pairs of nerves in the tongue, it is difficult to determine which of them contributes most to the formation of the papillæ." Minute researches upon this organ have, however, led to the conclusion, that the glosso-pharyngeal is distributed to the posterior, and the lingual branch of the fifth pair to the anterior papillæ, in which they are intertwined with the minute vessels in such a manner as to form the greater part of those bodies. Many of the minute filaments can, indeed, be traced directly into the papillæ even with the scalpel, but their termination in those bodies can be demonstrated by another process still more satisfactory. We were informed by the late M. Bogros, of Paris, that he had succeeded in injecting these nervous filaments of the fifth pair, by means of quicksilver, to their termination in the papillæ; and we had occasion to hear the same affirmation made by Professor Cnuveilhier,* of the School of Medicine. Whether, therefore, we admit the correctness of M. Bogros' opinions, in reference to the structure of the nerves, or not, the result of this experiment clearly proves, that the papillæ are principally supplied by the fifth pair of nerves, and, consequently, that it should be considered as the proper nerve of taste. There can, however, be but little doubt, that the glosso-pharyngeal nerve has also something to do with the sense of taste, otherwise it would not be distributed to the papillæ. Autenrieth, (Handbuch der Empirischen Mensch. Physiol. Th. 3. 5. 112,) indeed, supposed that the lingual and trigeminus were destined to receive different impressions; hence the reason, according to his views,

* Leçons Orale d'Anatomie, 1825.

"why the sensations of sweet and sour are perceived by the point of the tongue, those of bitter and alkaline by the posterior part of the organ—why the galvanic influence excites an acid taste near the apex of the tongue, and an alkaline towards its root." This, however, must be received as mere hypothesis, against the validity of which many objections might be urged. Less difficulty exists in relation to the conclusion, that these are the pruper nerves of taste, inasmuch as it is not only warranted by the anatomical characters of the orgau, but is also confirmed by several pathological phenomena. COLUMBUS, (de Re Anatomica. Venet. 1559, fol. p. 264,) mentions the case uf an individual deprived of the sense of taste, in whom the lingual branch of the fifth pair, instead of going to the tongue, was distributed to the back part of the head. This destruction uf the sense uf taste, has, moreover, sometimes taken place in cunsequence of tumours pressing upon the lingual branch uf the fifth pair, an instance of which is mentioned by PARRY, while the mubility uf the tongue has remained unimpaired. It is alsu true, that HEXERMANN, (Physiologie, 2. B. Kopenh. 1752. s. 293,) has mentiuned an instance of a different kind, in which, in extirpating one of the lingual glands, a branch of the hypoglossal nerve was accidentally divided, and a loss of the sense of taste was the consequence. In ubjection to this, however, Professor Rudolphi very justly ubserves, that it no mure authorizes us in concludiug from the result, that the hypoglossus is the nerve of taste, than that the blindness, which sometimes follows a division of the frontal nerve, warrants us in concluding, that it is the proper nerve of vision.

A question of some importance, connected with our present subject, is, whether any other parts than the tongue are endowed with the faculty of taste. Reasoning upon what has been said upon the structure and functions of that urgan, we should be disposed tu conclude that it alone is endowed with the sense in question. Pathology, however, furnishes some facts which gu far to controvert such a conclusion. JIEUSSEAU* has detailed the case of an individual who possessed the power of discerning the taste of different articles, notwithstanding she had no vestiges uf a tongue, except a small fleshy excrescence. Another case is described by BREDOT,† of a young lady who lost her tongue by the small-pox, but still retained the sense of taste tu such a degree as to enable her to distinguish the peculiar cha-

* Mem. de l'Acad. des Sc. de Paris, 1718.

† Act. Helvet. Vol. VIII. p. 184. Treviranus Philosophie der Lebendar Nat. Band 6, p. 226.

raeteristics of different articles of food and drink. Blumenbach,* mentions an individual who was born without a tongue, and yet possessed the faculty in question so perfectly as to be able to distinguish the taste of different substances, even when blindfolded. From all this it appears manifest, that some parts of the mouth, and espeeially the palate, are endowed with the power of perceiving the impression made by sapid bodies. This however must be considered as only auxiliary to the tongue, which is unquestionably the proper seat of that faculty. With regard to the faculty of touch which has been ascribed to the tongue by Treviranus,† we shall make no observations. It is no doubt capable, to a certain degree, of determining the characters and configuration of bodies, yet so imperfectly, that we do not think it deserves to be regarded as an organ of touch.

The observations of Professor Rudolphi on the faculty of vision, are of a very interesting character, and furnish an excellent exposition of the phenomena connected with that important function. Our restricted limits will not, however, admit of our entering into any details relative to the several topics embraced in this portion of his work. This we regret, as it contains many observations which could not be otherwise than interesting to our readers. The same excuse must suffice for our not touching upon that part of our author's labours which relate to the senses of smell and hearing, the subjects of the intelleetual operations, muscular motion, &c. all of which are treated with much ability.

The proper organ of voice is, according to our author, the larynx, which, says he, is easily shown, by making an opening into the trachea of an animal, which is always followed by an extinction of voice. If, moreover, we take the fresh larynx of some animal, and force air through it, a sound will be produeed which bears the eharaeter of the proper voice of the animal.

The parts of the larynx which are principally instrumental in the development of the phenomena of voice, are the vocal chords or ligaments of the glottis, which extend in a parallel direction from the thyroid to the arytenoid cartilages. These chords, as their name implies, have been generally considered of a ligamentous character. It was stated, however, several years ago, by Dutrochet, that they are merely a kind of aponeurosis of the thyreo-arytaenoideus musele. This opinion is not altogether correct, as has been very justly observed by Professor Rudolphi. Professor Muenz‡ has, however, demonstrated

* Hanbuch der Vergl. Anatomie, p. 330. † Biologie, B. 6.
‡ Handbuch der Anatomie, 1827. See the last number of this Journal.

that they are the proper tendons of a semiperiform muscle, situated immediately beneath the mucous membrane of the larynx, the fibres of which are implanted obliquely into them. The correctness of this assertion, we have repeatedly verified by our own dissections. Indeed, without these muscles, we can scarcely conceive how the condition of the chords in question could be sufficiently varied, to give rise to the several modulations of the voice.

Much difference of opinion has existed in reference to the mechanism of the voice. Dodart supposed, that it results from the passage of the air through the larynx, upon the principle of a wind instrument, while Ferrein ascribed it to vibration upon the vocal chords, like the strings of a musical instrument. It has, however, been shown by Kempelen, (Mechanismus der menschlichen sprache, Wien, 1791,) that both these explanations must be taken into the account, in which opinion most physiologists of the present day fully concur.

Much difference of opinion has existed in reference to the use of the epiglottis, some supposing that it is indispensably necessary in the production or modulation of the voice, while others have denied that it has any participation in that function.

"That it is not indispensably necessary for such a purpose," says Professor Rudolphi, "is proved by the circumstance, that it only exists in man and the mammalia. It has, moreover, been affirmed by Liscovius, (Diss. Sist. theoriam Vocis, Lips. 1814,) that when it is extirpated, no change of the voice is perceptible."

It seems to be more important as a means of preventing particles of food and drink from falling into the larynx: an office, which it has been affirmed by Magendie not to perform. Upon this point, the opinion of our author is opposed to that of the French physiologist, against which he urges some very conclusive arguments. It was ascertained by Reichel, in his experiments, (Diss. de usu Epiglotidis, Berol. 1816,) that the extirpation of the epiglottis occasioned the animal to experience great difficulty of swallowing.

"But," says our author, "not to draw our inferences from animals, Kohlrausch presented me the larynx of an individual, who had died of laryngeal phthisis, the epiglottis of which was entirely destroyed, except a very small portion of its base. This man experienced great difficulty of deglutition, and could only swallow fluids by mixing them with some substance, so as to form a kind of paste."

Numerous cases, showing a similar result, are detailed in the work of Dr. Sachse, on laryngeal and tracheal phthisis, which has been noticed in a preceding number of this Journal. Professor Rudolphi thinks, that besides this office, the epiglottis seems, in those animals

that breathe through the nose with the mouth closed, to direct the air into the larynx.

Our author is also at variance with MAGENDIE and CLOQUET, upon the distribution of the nerves of the larynx. It has been affirmed by these gentlemen, that the recurrent nerve is distributed exclusively upon the muscles which dilate the glottis, viz. the crico-arytaenoidei postici et laterales, and the thyreo-arytaenoidei—and that the constrictors receive their nerves from the superior laryngeal. Against the correctness of this assertion, he appeals to a preparation of the larynx made by SOHLEMM, and deposited in the Anatomical Museum of Berlin, from which he concludes, that ANDERSCH, SOEMMERING, PORTAL, and BICHAT, were correct in their descriptions of these nerves.

"That the superior laryngeal nerve forms a connexion with the branches of the recurrent in the larynx, and that both send filaments into the constrictors, as well as into the dilators of the glottis."

We have directed our researches, with some attention to this subject, and have never been able to find any thing to induce us to concur with Magendie and Cloquet, in the description of the distribution of the nerves of the larynx, which they have given, but have always observed filaments passing from the superior and inferior laryngeal nerves alike into the dilators and constrictors, as represented by Rudolphi, and the authors quoted.

We might go on to examine the contents of the third volume, but we find that we have already reached our limit, and shall be obliged, for the present, to forego that satisfaction. It should, however, be stated, that the work is not yet completed, and that the remainder of it will be comprised in a fourth volume. When, therefore, that part of it reaches us, we may be induced to recur to the labours of our author. On the present occasion, we cannot take leave of him, without testifying the great pleasure and instruction we have derived from the examination of his work. True, we have differed with him in opinion upon some points, but in the main, candour has compelled us to commend. It unfortunately seldom falls to the lot of the reviewer, to examine works like the present. When, therefore, he is called upon to express an opinion, it is peculiarly gratifying to him to find so much in the labours of his author to entitle him to his favourable consideration. A translation of the work in question, was begun some time since, in England, and the first volume published; but we fear the design has been relinquished. We regret this the more, as we think it should be in the library of every medical man; and we unhesitatingly affirm, that as an elementary work for students, we consider it superior to any we have yet seen. E. G.